SECTION 6. ESV FREQUENCY ENGINEERING

51. FREQUENCY ENGINEERING FOR ESV. An ESV is a volume of airspace in addition to the normal FPSV of a NAVAID, protected from interference from other NAVAID facilities.

a. An ESV merely adds to a standard FPSV. The ESV extends the standard FPSV in a particular direction, distance, altitude, and shape. Note ESV's are designated in altitude MSL. Since power availability curves are in altitude AGL, the FMO will need to make an appropriate adjustment when analyzing ESV suitability.

b. An ESV can be placed on any VOR, ILS-DME or TACAN. When a DME or TACAN and VOR are paired, BOTH shall have identical ESV's for safety. ESV's may be added to any class of NAVAID facilities, including NDB's.

c. An ESV is frequency engineered just like the parent facility using the same facility separation and ESR curves.

d The extension of the coverage distance involves a new dimension, not covered in previous sections of this appendix. That is the power availability of the facility at the extremity of the ESV. In all standard FPSV's, the power availability of a standard NAVAID has been assured. However, extending the FPSV substantially can put the outer most critical point outside the acceptable signal level range. For instance, an H-VOR has an FPSV of 130 nmi. If it were requested to protect an ESV at some azimuth out to 165 nmi, the FMO should first check signal availability before doing the whole study. Obviously, if the standard signal strength is not available at the critical point, the ESV cannot be used, regardless of the freedom from calculated interference for both cochannel and adjacent channel. The FMO should ask the proponent to adjust their requirements to meet the available signal level. If the signal level requirement is marginal, flight inspection can determine the minimum altitude.

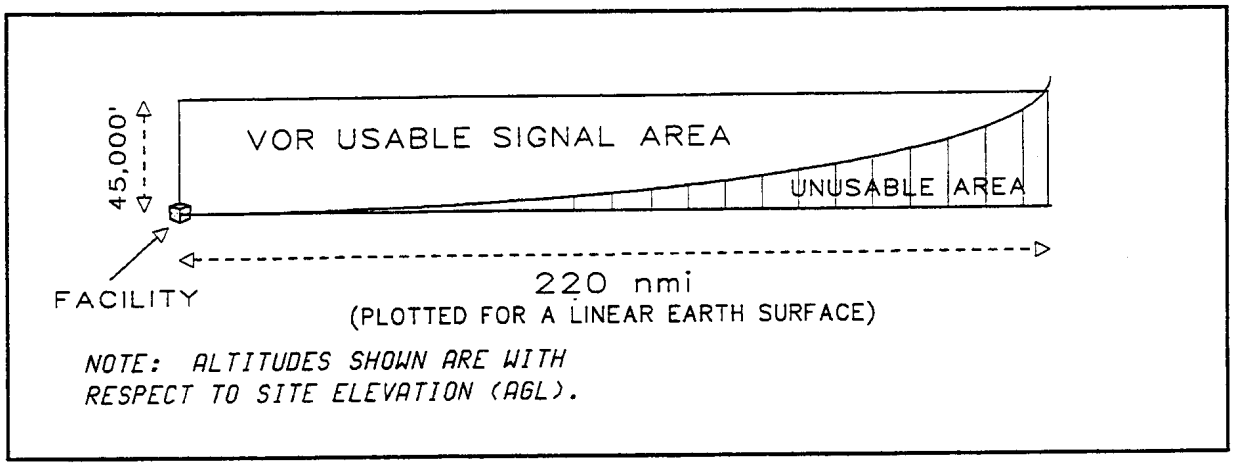
52. MINIMUM POWER AVAILABLE REQUIREMENTS. To meet ICAO and FAA avionics standards, the various NAVAID receivers must have the indicated minimum power available to the aircraft at the most critical point. The table in figure 165 lists those minima.

FIGURE 165. POWER AVAILABLE REQUIREMENTS FOR NAVAID RECEIVERS

FACILITY	MINIMUM POWER
VOR	-123.0 dBW @ 117.95 MHz
ILS LOCALIZER	-123.0 dBW @ 111.95 MHz
DME & TACAN (> 18,000')	-114.5 dBW @ 1213 MHz
(< 18,000')	-109.0 dBW @ 1213 MHz

53. AN EXAMPLE OF POWER AVAILABILITY. The typical geographic (distance vs. altitude) usable signal coverage for a VOR is shown in figure 166.

FIGURE 166. POWER AVAILABLE – VOR



a. Figure 166 is a composite of VOR power available curves and is for illustrative purposes only.

b. Suppose a proposed ESV asks for 160 nmi @ 18,000' to 25,000'. (Note that this request will be for MSL altitude.) From figure 165, it will be seen that a -123 dBW level is required. Assume the site at 2,000' elevation.

c. Refer to figure 171, the power available curves for VOR. Trace the 160 nmi line from the bottom of the graph up to the -123 dBW curve. At that intersection, follow the horizontal line to the left to find that the minimum altitude to reach the needed power level is 26,000' AGL, or 28,000' MSL. On that basis, the ESV could not be used below 28,000' MSL, at 160 nmi. The requestor would have to be informed to revise the ESV request downward in mileage or upward in ESV floor before any further study could be done.

d. Had the ESV been for 160 nmi from 28,000' - 45,000' MSL, it would have met the needs of figure 171.

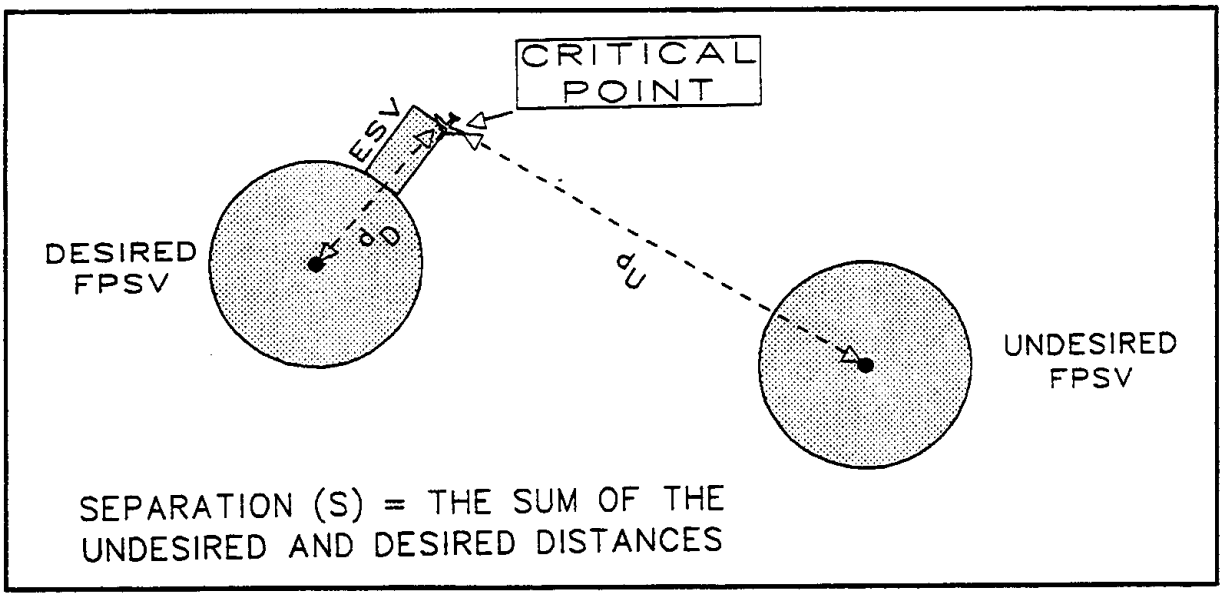
54. THE INTERRELATIONSHIP OF THE VOR AND DME/TACAN ESV. If a VOR exists and there is an associated DME/TACAN, they must have identical ESV's for safety reasons. Refer to figure 173. It will be noted that a TACAN cannot meet a 160 nmi requirement except above 32,000' AGL. Thus any ESV which will be certified as protected must have the power availability for both collocated facilities as well as frequency protection for both before it can be approved. In the example of paragraph 53, the lowest permissible VORTAC ESV for 160 nmi would be 32,000', or some lower minimum altitude at a lesser radial distance.

55. VOR/DME/TACAN ESV DETERMINATION PROCEDURE. Once the power available has been determined to be satisfactory, the actual calculation to determine protection can begin. The

same curves used for standard FPSV protection are used for ESV determination, so they will not be repeated in this section. Whenever an ESV is to be calculated, use the curves associated with the facility in the previous sections.

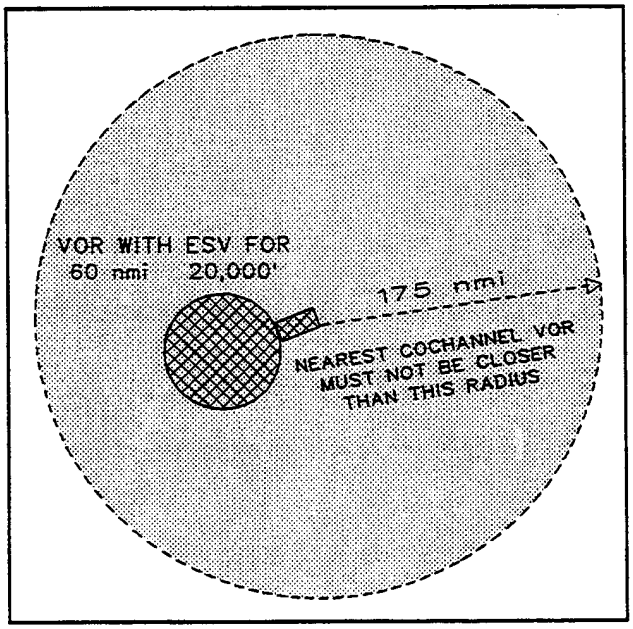
a. When an ESV is designed, it is necessary to make the determination at the critical point. That point is defined as that which is furthest from the desired facility and simultaneously closest to the undesired facility, as shown in figure 167.

FIGURE 167. CRITICAL POINT MEASUREMENT OF AN ESV



b. Refer to figure 168 and figure 19 in section 2, VOR separation curves for ESR = +23 dB. Following the 60 nmi base line of figure 19 upward to its intersection with the 20,000' line will produce the value of (S) = 235 nmi. With the 60 nmi ESV, that means any cochannel L-VOR or T-VOR must be at least 175 nmi from the desired critical point. Were the cochannel VOR an H-VOR, the ESV would be automatically protected in that direction, due to the H-VOR separation requirement of 395 nmi previously required for the two to be cochannel at standard FPSV's.

FIGURE 168. EXAMPLE OF VOR ESV BY CALCULATION



c. If a DME or TACAN were collocated, the DME/TACAN separation requirement would have to be determined in the same manner. Refer to figure 44, section 2, DME/TACAN separation curves for ESR = +11 dB. Follow the same procedure as subparagraph a. By interpolation, (S) = 235 nmi.

d. To meet the ESV protection required in figure 158, it would be necessary that the nearest cochannel VOR/DME be at least 175 nmi away from the critical point. As in subparagraph a, if the nearest cochannel is an H-VOR/DME, the requirement of 395 nmi (S) would more than protect the example ESV.

e. Adjacent channel determination is made exactly the same way as a VOR/DME/TACAN FPSV is frequency engineered. Using the values of section 2, paragraph 1e, the appropriate ESR curves are used to determine the required distance from the critical point on the ESV to the nearest adjacent channel, for both VOR and DME/TACAN.

56. ILS-DME ESV DETERMINATION PROCEDURE. An ESV on an ILS is handled the same way as the VOR in paragraph 55 using the appropriate curves and the LOC antenna radiation patterns.

a. The only difference is that the ESV critical point will require reading the appropriate curves at a different distance, and probably a different altitude than a standard FPSV.

b. As indicated in section 3, the DME function nearly always requires a greater geographical separation than its associated ILS. Therefore, the FMO should check the DME requirements first. If the DME ESV fits, the ILS ESV will nearly always fit easily.

57. ESV SPECIAL CONSIDERATIONS.

a. ESV operational radials and areas have a definite tolerance to maintain.

(1) Radials

(a) VOR/DME/TACAN ±4.5°.

(b) ILS ±10°.

(c) NDB ±10°.

(2) Wedge areas

(a) VOR/DME/TACAN — add 4.5° in both directions.

(b) NDB — add 10° in both directions.

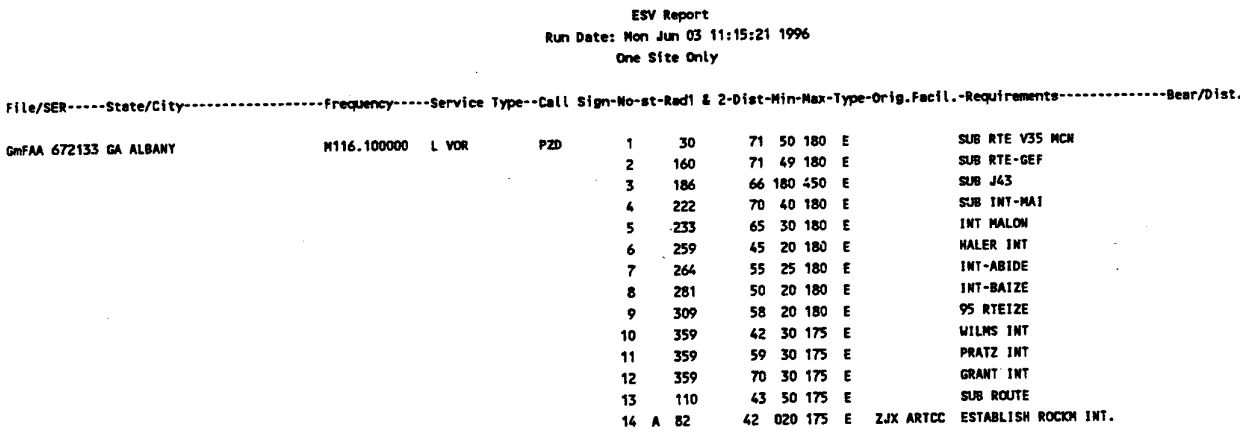
(3) Holding patterns (HP) are described by an arc enclosing two radials, e.g., 306-322°, 83 nmi, and shall enclose the HP.

b. Each FMO shall enter all ESV requests in the AFM. The AFM will be used to maintain a national database of ESV's in the NAS.

c. When the FMO receives a request (FAA Form 6050-4) to establish, revise or cancel an ESV, it shall be entered into the AFM. The FMO shall engineer each ESV and forward to the Flight Inspection Office for a flight check. The results of these evaluations shall be transmitted to ASR for inclusion into the national database.

d. FMO's shall review each ESV in their regions on a yearly basis to confirm the accuracy of the national ESV data base.

FIGURE 169. SAMPLE ESV RECORD FORMAT



ESV Report
Run Date: Mon Jun 03 11:15:21 1996
One Site Only

File/SER	State/City	Frequency	Service	Type	Call Sign	No	st	Radl & 2-Dist	Min	Max	Type	Orig.Facil.	Requirements	Bear/Dist.
GmFAA 672133	GA ALBANY	M116.100000	L	VOR	PZD	1		30	71	50 180	E		SUB RTE V35 MCN	
						2		160	71	49 180	E		SUB RTE-GEF	
						3		186	66	180 450	E		SUB J43	
						4		222	70	40 180	E		SUB INT-MAI	
						5		233	65	30 180	E		INT MALON	
						6		259	45	20 180	E		MALER INT	
						7		264	55	25 180	E		INT-ABIDE	
						8		281	50	20 180	E		INT-BAIZE	
						9		309	58	20 180	E		95 RTEIZE	
						10		359	42	30 175	E		WILMS INT	
						11		359	59	30 175	E		PRATZ INT	
						12		359	70	30 175	E		GRANT INT	
						13		110	43	50 175	E		SUB ROUTE	
						14	A	82	42	020 175	E	ZJX ARTCC	ESTABLISH ROCKM INT.	

58. thru 62. RESERVED